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16. Abstract The objectives of this project are two-fold: to develop methods of monitoring the interaction between volcanic heat and the snow and ice cover of Mt. Wrangell and, to evaluate the potential applicability of ERTS data to studies of the mass balance of the entire 5000 km ² ice cap in the Wrangell Mountains. The emphasis of our investigations since we began receiving data has been directed towards assessing the applicability of ERTS data to the project objectives, and determining the most efficient methods of extracting the required information from the ERTS images. To date, our results show that use of the ERTS data in digital form can provide the information required to meet the first objective above. Investigations of the applicability of the ERTS data to the second objective have given encouraging results, but our studies are still in a preliminary stage.			
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I. INTRODUCTION

This report summarizes the work performed and conclusions reached during the first six months of Contract No. NAS5-21833, ERTS-1 Project No. 110-13, "Glaciological and Volcanological Studies in the Wrangell Mountains, Alaska".

During this reporting period, the emphasis of this study has been in the direction of evaluation of the applicability of ERTS data to the objectives of this project, and to experimentation with enhancement procedures. In addition, we have conducted preliminary studies of aerial photographs and IR scanner data collected for us by NASA on flights in which we participated.

Funding for this project is minimal (due to funding limitations imposed by NASA on the entire University of Alaska ERTS-1 project) and provides for only 1-1/2 months of principal investigator time. As a result, our efforts have been restricted primarily to feasibility studies and data organization.

II. STATUS OF THE PROJECT

A. Objectives

The overall objectives of the project are two-fold: to develop methods for monitoring the interaction between volcanic heat and the snow and ice cover of Mt. Wrangell and, to evaluate the potential applicability of ERTS data to studies of the mass balance of the entire 5000 km² ice cap which covers the Wrangell Mountains. The emphasis of our investigations since we began receiving data has been directed towards assessing the applicability of the ERTS data to the project objectives and determining the most efficient methods of extracting the required

1

data from the ERTS images.

B. Accomplishments During the Reporting Period

1. Preliminary Investigations

In late July, 1972, the Principal Investigators participated in a flight of the NASA NP3A aircraft for the purpose of acquiring photographic and thermal IR (RS-14 scanner) data over the test area. A first-look analysis of this data was later performed. Additional ground truth data of the test area, from other sources, were also assembled. A review of the literature regarding the application of aerial photography to the problem of monitoring the mass balance of glaciers was continued, with the objectives of determining how much of the information needed might be observed from the ERTS images. Finally, the data handling plan was revised in light of our experience with the ERTS data.

2. Applicability of ERTS-1 Data to the Project Objectives

In order to monitor the interaction between volcanic heat and the ice and snow cover of Mt. Wrangell, it is necessary that changes in the area of bare rock exposed by melting at the summit be observed. Our results to date indicate that this can be done. On image 1010-20331 (August 2, 1972) areas of bare rock on the summit are clearly visible on the 9-1/2 x 9-1/2 inch paper prints supplied by NASA. Image 1026-20220 (August 18, 1972) shows high, thin clouds over the summit being driven by southerly winds, which usually indicates a storm developing in the area. This was verified on image 1027-2075 taken the following day (August 18, 1972) when the summit was under heavy clouds. Finally, on August 20, 1972, the third day of this sequence, the summit is clearly shown on image 1028-20333. Visual inspection of the image was sufficient to show that the summit was entirely snow covered with the bare rock visible.

Subsequent clear weather satellite passes over the summit occurred on September 7 (image 1046-20332), September 23 (image 1062-20221), September 24 (images 1063-20273 and 1063-20280), September 25 (image 1064-20331), October 12 (images 1081-20275 and 1081-20281). However, the sun angle during these passes changed from 31 degrees on September 7 to 20 degrees on 12 October. This caused heavy shadows in the summit area so that bare rock could not be identified with certainty. As a result, we decided to investigate enhancement techniques which could be utilized to separate snow and bare rock in areas covered by heavy shadows.

Digital tape of one of these images (1062-20221) was ordered by the University of Alaska ERTS Data Library. Printouts of density levels (by pixel) over the summit were obtained for bands 5 and 7 of the image. These were partly contoured, so that the relevant areas could be located, and the densities in these areas were then examined. The results showed clearly that a significant variation exists in the densities within the areas of heavy shadow, which could not be observed on the photographic products and further, that the darker localities coincide with the bare rock outcrops which were present prior to the storm of August 19 (see above).

The possibility that melting could occur from solar heating at the summit of Mt. Wrangell during September is virtually non-existent; we know this from our previous field work at the summit. Therefore, the removal of snow from the outcrops must, of necessity, be attributed to volcanic heat.

As a result of these studies, we believe that the ERTS data are adequate to supply the information needed to meet this aspect of the project objectives.

The applicability of the ERTS data to the study of the mass balance

of the Wrangell ice cap is still under investigation. However, there is no doubt that it will be possible to assign a qualitative (i.e., positive or negative) value to the mass balance of each glacier flowing off the Wrangell Mountains, based upon the relationships between snow, firn and glacier ice at the end of the yearly melt season. Boundaries between these zones are visible on the ERTS images without enhancement.

III. NEW TECHNOLOGY

None

IV. PLANS FOR NEXT REPORTING PERIOD

During the next reporting period we intend to acquire digital tapes of some of the images of the Mt. Wrangell summit area taken before and after the storm of August 19, 1972, and to process these in the manner described above. An Interpretation Systems, Inc. color display unit is scheduled to be installed in the University of Alaska ERTS Data Library shortly, as we plan to make use of this instrument for enhancing the imagery. In particular, we believe that the use of density slicing techniques will permit us to prepare accurate maps of the extent of bare rock on the summit.

V. CONCLUSIONS

The results of our work to date indicate that changes in snow and ice cover at the summit of Mt. Wrangell, resulting from new snowfall and melting by volcanic heat, can be observed on the ERTS imagery. Further, we have determined that the ERTS data can be utilized to distinguish between snow, firn and glacier ice, so that qualitative assessments of yearly mass balance of the glaciers flowing out of the Wrangell ice cap

can be made.

VI. RECOMMENDATIONS

None

VII. PUBLICATIONS

None

VIII. REFERENCES

None

APPENDICES

Appendix A - Change in Standing Order Forms

None

Appendix B - ERTS Data Request Forms

See attached form

Appendix C - ERTS Image Descriptor Forms

None

Appendix D - Significant Results

Attached

ERTS DATA REQUEST FORM

560-213 (7/72)

NDPF USE ONLY

D _____
 N _____
 ID _____
 DTM _____
 TM _____
 TM APP. _____

1. DATE February 20, 19735. TELEPHONE NO. (907) 479-7450 ☐ NEW2. USER ID UN/594

6. CATALOGUES DESIRED

4. SHIP TO: Dr. Carl S. Benson

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081-20281	N61-22/W144-28	M	D	9		1	U

THIRD BI-MONTHLY PROGRESS REPORT
UNIVERSITY OF ALASKA
ERTS PROJECT NO. 110-13

February 20, 1973

PRINCIPAL INVESTIGATOR: Carl S. Benson

TITLE OF INVESTIGATION: Glaciological and Volcanology Studies on the
Wrangell Mountains, Alaska

DISCIPLINES: Mineral Resources, Geological Structure and Land Form
Surveys/Water Resources

SUBDISCIPLINES: Volcano surveys/glacier surveys

SUMMARY OF SIGNIFICANT RESULTS:

In the last bi-monthly report for this project, we noted that, at high sun angles, it is possible to observe changes in the snow cover at the summit of Mt. Wrangell, resulting from snow fall and melting by volcanic heat. However, at low sun angles the problem of identifying bare rock in areas of heavy shadows prevents these observations from being made in the photographic images of the ERTS data. During this reporting period, we examined the computer printout of density levels by pixels for image 1062-20221 (September 23, 1972, sun elevation 27 degrees) in order to determine whether outcrops of bare rock could be observed within heavy shadow areas which appeared totally black on the photographic images. The range of density levels within these zones was surprisingly large (ranging from level 14 to level 50) and the darker areas were found to coincide with the outcrops observed at high sun angles. As a result, it appears that heavy shadows resulting from low sun angles will not hinder the investigation.